J. LUCIANI.

EXPLOSIVE.

APPLICATION FILED DEC. 19, 1907.

989,375. Patented Apr. 11, 1911.

Fig. 1

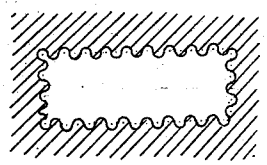


Fig. 2

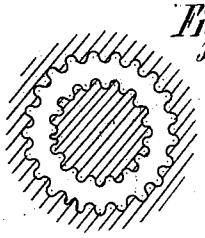


Fig. 3

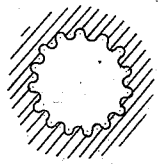


Fig. 4

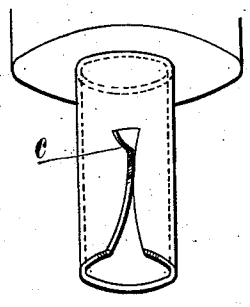


Fig. 5

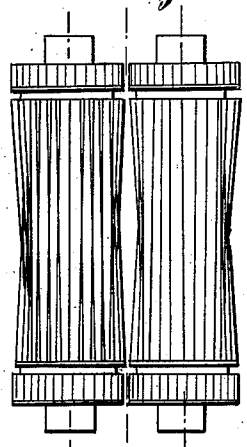


Fig. 10

Fig. 11

Fig. 6

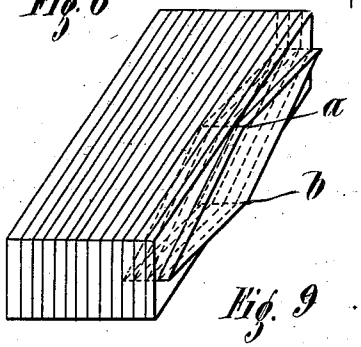


Fig. 8

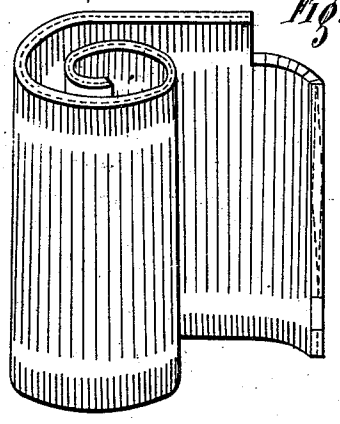


Fig. 9

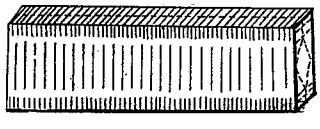
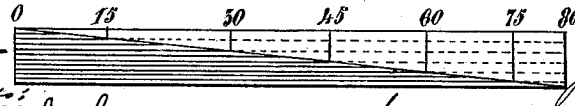


Fig. 7



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Attys.

UNITED STATES PATENT OFFICE.

JACQUES LUCIANI, OF PARIS, FRANCE.

EXPLOSIVE.

989,375. Specification of Letters Patent. Patented Apr. 11, 1911.

Application filed December 19, 1907. Serial No. 407,221.

To all whom it may concern:

Be it known that I, JACQUES LUCIANI, a citizen of the Republic of France, residing at Paris, France, have invented Improvements in Explosives, of which the following is a specification.

For some years inventors have been working on lines that constantly tend to augment what may be termed the "progressivity" of powders of all kinds and particularly that of colloidal powders. What is meant by tendency to augment progressivity may be understood by the following statement:—The best powder for fire arms is that which communicates the greatest velocity to the projectile progressively and yet damages the fire arm the least; for this it is necessary that the pressure of the gases relatively feeble at the commencement, should gradually increase during the progress of the projectile along the barrel of the fire arm. The realization of this "progressivity" has been attempted in some instances by forming each section of the explosive charge of several superposed layers of explosive, whose several chemical compositions are such that the velocity of combustion will increase while the area thereof will diminish from the outer surface to the center of the charge. In other cases instead of effecting such a result by altering the chemical composition of parts of the charge it has been proposed to increase and regulate the progressivity to a predetermined degree, for an equal volume, from the surface of the element. Hitherto however such attempts have failed in obtaining with certainty and in a constant manner the regularity of combustion necessary in a war explosive. Moreover the irregularity and the insufficiency of the combustion of a charge carried to the muzzle of a fire arm behind the projectile, result in residual incompletely consumed substances, where tardy combustion gives rise to a more or less intense light or glare always inconvenient from a tactical point of view.

Now this invention has for object to provide an explosive for use in fire arms that, while possessing the desired progressivity, will nevertheless be so completely consumed in the barrel as to obviate this detrimental incomplete combustion and resulting light or glare at the muzzle. For this purpose explosives such as now employed, whether having a nitroglycerin base or not, are subjected to a preliminary treatment under appropriate conditions according to which there is effected the incorporation therewith of certain substances; the so treated mass being subsequently subjected to a further and mechanical treatment which treatment comprises the following consecutive operations:—obtaining a sheet of uniform thickness; reduction of the thickness of this sheet by a preliminary rolling; marking one or both faces of the sheet with grooves the depth of which decrease regularly from the edges of the sheet to its center; and a second and final rolling which again reduces the thickness of the sheet.

In order that the invention may be readily understood reference will be made in the following description thereof to the accompanying illustrative drawings.

Figures 1 to 3 show sections of exit orifices made in a vat adapted to contain the explosive in a plastic state. Fig. 4 shows an arrangement whereby the explosive can be easily obtained in flat sheets of uniform thickness. Fig. 5 shows the outline of the cutters employed for cutting grooves of gradually increasing depth in a sheet of explosive. Fig. 6 illustrates an example of a grooved strip of explosive of rectangular shape. Fig. 7 shows the profile of a groove of gradually decreasing depth. Fig. 8 is a view of a charge formed by rolling up a single rectangular sheet or strip of explosive formed with grooves of gradually decreasing depth, the charge being provided with so-called fringes or incised edges in a manner heretofore known. Fig. 9 illustrates another example of a grooved rectangular tongue or strip of explosive of greater thickness than the sheet shown in Fig. 8, and likewise provided with fringes. Figs. 10 and 11 show an explosive element of cordite and an element of tubite, respectively, with grooves of gradually decreasing depth.

With regard to the chemical treatment of the explosive according to this invention:—In use with pieces of ordnance, there is incorporated with the powder, whether a nitroglycerin powder or not, from about 2 per cent. to about 7 per cent. of bleached bees wax or carnauba wax (which is for this purpose sufficiently near in chemical characteristics to bees wax), and about 2 per cent. of bicarbonate of magnesia or of bicarbonate of ammonium. These proportions can be varied within more or less narrow limits but in practice it has been found that

in most cases the proportions above indicated produce satisfactory results. The paste thus comprised is treated as follows:— It is placed in a malaxator with an alcohol, ether, acetone, or other appropriate solvent, and carefully malaxated for about five hours. This length of time is necessary especially in cases where there has been an addition of nitroglycerin in the powder treated. The mass is then placed in a receptacle of suitable form in the bottom of which is an opening affording an outlet under pressure to the material treated. The section of this opening may be one or other of those indicated diagrammatically in Figs. 1, 2 and 3 of the drawings. In the case of the section indicated for example in Fig. 1 the powder issues in the form of tongues or strips while with the section indicated in Fig. 2 it issues in the form of tubite, and, with the section shown in Fig. 3, in the form of cordite. It will be seen however that in each case the edges of the opening are, in a way, festooned or corrugated so that the ribbon, tube or cylinder of explosive that issues from the receptacle is scored with striæ, or longitudinal undulations which considerably augment the surface thereof and facilitate the evaporation of the solvent.

The obtaining of explosive in a form having relatively large flat surfaces presents much difficulty in the course of manufacture; the gelatinized product on its issue from the vat whence it is driven by compression does not present sufficient consistency to preserve the form of a rigorously flat sheet, easy to roll.

Fig. 4 illustrates apparatus which enables a flat sheet of powder of large surface to be easily obtained. For this purpose the bottom of the reservoir is formed with an annular outlet orifice of large diameter the section of which is analogous to that employed for obtaining tubite. Through this opening the gelatinous mass emerges in the form of a tube which owes its consistency and regularity of thickness to the geometrical properties of the tube which constitutes it. Upon the length of this tube is arranged at any point a knife *c* which cuts it longitudinally; the tube therefore, from this point is opened, spread out, and transformed into a flat sheet of uniform thickness which falls upon the conveyer table. The bands or tubes thus preliminarily striated fall onto an endless apron which carries them on to a heating surface whereon the powder is subjected to the action of a temperature of about 60° centigrade until it loses the major part of the contained solvent which is thereby evaporated. The thus treated paste containing not more than so much of the solvent as is necessary to preserve a certain degree of plasticity, is caused to pass between the cylinders of a rolling mill, which is capable of fine adjustment, to reduce the thickness by about one-third. Under the action of this preliminary compression the bees wax penetrates the interstices left by the partial evaporation of the solvent and impregnates the mass of the explosive which issues from the rolls in the form of a translucent sheet. The powder is then exposed to the air for about thirty minutes, which deprives it of nearly all its solvent and makes it slightly more rigid. After having been brought to this state the powder is then grooved. For this purpose it is caused to pass between two milling cutters of concave profile and striated periphery which engrave grooves in the band or sheet of powder upon one or both faces, depending upon the pressure it is desired shall be produced in the barrel, of the fire arm, the dimensions of the grooves being appropriate to the fire arm for which the powder is to be adapted. This apparatus is represented in elevation in Fig. 5. In order to produce satisfactory results from such grooves in the matter of suppression of light or glare at the muzzle, and stability of the powder, special regard must be had to the number, arrangement, and depth thereof. Fig. 6 shows diagrammatically the section of a sheet of powder thus grooved lengthwise upon both faces; these grooves are relatively deep at the edges of the sheet and diminish in depth as they approach the center, so that the section of the plain or non-grooved portion of the sheet is somewhat lozenge-shaped. The grooves are thus of gradually increasing depth from the center toward the edges of the sheet. The variations of the diagonal *a b* of this lozenge shaped section will determine the corresponding variations in the velocity of combustion of the powder. This may be seen by examining the following table relating to a sheet of 80/100 of a millimeter thickness of a constant weight fired in a gun of 8 millimeters bore.

Thickness of the charge.	Degree of depth of the groove.	Weight of the charge.	Pressures.	Velocities.
80/100	15/100	2.50	855	537
	30/100	2.50	1025	610
	45/100	2.50	1395	632
	60/100	2.50	1620	683
	70/100	2.50	1820	710
	80/100	2.50	2024	729

This table shows distinctly how one can vary at will for a charge of given weight, the speed and pressure in a gun barrel, by varying the number and depth of the grooves made in the explosive. In the case for example of ten charges each of equal thickness, and weight; fired from the same fire arm and projecting a similar projectile then, by engraving in the charges grooves increasing in depth from the first onward, there will be obtained ten different pressures

and speeds, the speeds increasing correspondingly to the increased depth of the grooves.

By establishing an empirical relation for each fire arm as to the number, arrangement and depth of the grooves corresponding to the prevention of light or glare at the nozzle it is possible to determine the combined result upon a projectile of a charge comprising (say) ten elements or sections each having a different groove and burning at a different speed and it is in such way that there has been obtained a charge such as represented in Fig. 6, each groove varying in depth from one end to the other. Fig. 7 shows the correspondence between the table above indicated and the profile of a groove. The sheet of powder thus grooved then undergoes a third operation of the highest importance which consists in a second and final rolling and the efficacy of which is assured by the striæ and grooves, into the hollows of which the excess of material driven back by the rollers is distributed and which only partially fills them up. The compression due to this supplementary rolling operation is so regulated as to reduce the thickness of the strip or tongue from about five per cent. to about fifty per cent. according to the pressure it is desired to obtain in the fire arm, this pressure being correspondingly less to the reduction of thickness effected. This reduction of pressure may attain for an equal weight of the charge and for an equal initial velocity, a proportion of from about thirty per cent. to about fifty per cent. Powder thus produced may be employed either in the form of a single rectangular body constituting the charge by itself alone, see Fig. 8; or in the form of rectangular tongues, see Fig. 9; tongues or strips, cordites, see Fig. 10; tubes, see Fig. 11; etc., adapted to be tied up in bundles and placed in the chamber of the fire arm, the grooves being in the direction of the axis of the barrel. The essential feature is that the elements be formed with grooves gradually decreasing in depth as shown in Fig. 7.

In powder as thus above set forth the wax incorporated therewith renders more compressible the nitrated elements that enter into the composition of the sheet of powder, while nevertheless preventing the powder from disintegrating under the influence of the rolling and compression operations to which it is submitted. These bodies in a way envelop such of the solvent as ultimately still remains in the explosive and consequently prevent further evaporation, which evaporation is the initial cause of those decompositions of these explosives which are so dangerous. The beeswax may be replaced by other similar plastic and combustible substance or substances such for examples as castor oil, pine resin, vaseline and the like, but the beeswax is found to apparently give the best results.

What I claim is:—

An explosive for the purpose and of the character described comprising a powder grain having two opposing surfaces provided with grooves gradually decreasing in depth from the edges of the grain toward a median line in each of said surfaces, a section of said grain on the plane of said grooves having a lozenge shape.

Signed at Paris, France, this sixth day of December, 1907.

JACQUES LUCIANI.

Witnesses:
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